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(54) **Automated data storage system space allocation.**

(57) A method and system for automatically allocating space within a data storage system for multiple data sets which may include units of data, databases, files or objects. Each data set preferably includes a group of associated preference/requirement parameters which are arranged in a hierarchical order and then compared to corresponding data storage system characteristics for available devices. The data set preference/requirement parameters may include performance, size, availability, location, portability, share status and other attributes which affect data storage system selection. Data storage systems may include solid-state memory, disk drives, tape drives, and other peripheral storage systems. Data storage system characteristics may thus represent available space, cache, performance, portability, volatility, location, cost, fragmentation, and other characteristics which address user needs. The data set preference/requirement parameter hierarchy is established for each data set, listing each parameter from a "most important" parameter to a "least important" parameter. Each attempted storage of a data set will result in an analysis of all available data storage systems and the creation of a linked chain of available data storage systems representing an ordered sequence of preferred data storage systems. Data storage system selection is then performed utilizing this preference chain, which includes all candidate storage systems.

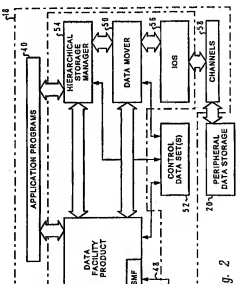

Fig. 2

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Technicel Field

The present invention reletes in general to computer-controlled dete storage systems and in particular to menegement of the selection of e particuler device within e data storage subsystem. Still more particularly, the present invention reletes to eutomated data storage system space allocation within e data processing system utilizing a set of prioritized deta set parameters.

Background Art

Initially, computer systems utilized e job control languege (JCL) which required the computer usar to specify meny parameters of progrem execution, including specifications for peripheral data storage. Thus, eech time the peripheral deta storage was changed, e corresponding change was required in the JCL statements for the programs to be executed. One example of JCL control of a date processor is shown in U.S. Patent No. 4,104,718, issued to Poblan et al. This express interaction between the operation of e paripheral deta storage systam and usar application progrems represents en increasingly difficult espect of computar programs due to the immensity of storage capacity which is eveilable in modern informetion processing systems.

It would be desirable to allow a usar or application programmer to issua specifications, prefarably implicitly, for program exacution and deta storage requirements which are at a relativaly high or "logical" leval. The term "logical" as utilized herein refers to the specifications for desired program execution, particularly for paripheral data storage. It would also be desirable that all allocation and controls for peripheral data storage be removed from direct intervantion by the epplication progremmer. One exampla of an application of the "logical" leval control of storage devices is illustrated in U.S. Patent No. 4,403,288, issued to Christian et al., wharein one physical device was addressable as four separate logical devices.

The proliferetion of direct access storage devices (DASD) within peripheral dete storage subsystems has resulted in a centralized DASD storage space allocation program called "DADSM" (Direct Access Device Space Management). However, the epplication progremmer still hed to request spece in terms of device parameters and types. An example of this technology mey be seen in "Asynchronous Allocation Requests" Duvall et al., IBM Technical Disclosure Bulletin, Volume 235, No. 8, January 1983, pp. 4148-4150.

A virtuel date storage system which employs a memory control processor which is external to tha host processor which divides user-defined data sets into blocks of e size convenient for storage in peripheral data storege devices is illustrated in U.S. Patent No. 4,467,421, issued to White. Thet system utilizes a memory processor to assign these blocks to storege locations on peripheral dete storega devices. The memory processor intarcepts the device oriented input/output commands from the host processor and adjusts operation of the peripheral data storage system to make it more efficient. This system still requires the application progremmer to utilize JCL statements that are device dependent, even if an external memory processor interprets the device dependencias differently than intended by the application programming. While this arrangement may aase the affects of changing device types and the like, it still burdens tha application programmer device perameter consideretions.

U.S. Patent No. 4,638,425, issued to Hertung, shows a cached direct access storege device (DASD) subsystem in which the epplication programmer mey insert a storege peremeter indication of whether certain data records may be storad primarily within volatile peripheral storaga, or primarily ratentively stored within direct access storage devices within the peripheral system. Whan storad primerily within cache, performance is anhancad; howevar, the epplication program is responsible for any lost data due to power problems or equipment failures. While the usa indication provided within this system appears to operate on e relatively high "logical" leval, it may be seen that tha application programmar still is requirad to understand important operational charactaristics of tha paripheral data storage system.

U.S. Patent No. 4,607,346, issued to Hill, teaches an implicit control of a peripheral DASD based upon tha usar or epplication programmar spacifying "access densities" for a given program. Based upon such spacified access densities, tha data to be stored is directed to differant portions of a DASD. From this description it may be saan that tha application programmer must still be involved with the device parameters; howevar, the device parametar designations are complicated with the desired access peremeters of tha epplication program.

U.S. Patent No. 4,528,624, issued to Kamionka et al., teaches the selection of peripheral devices for allocations prepatory to peripheral data storege based upon maximum free storage spece within each device. This selection is independent of the actual storage capecity of the various devices. This is a simple but relatively effective selection process which mey be machine executed after the application programmer hes completed the device relatad JCL statement; i.e., the machine operations for data spaca allocations do not alleviate all of the interections between the epplication progremmer and device characteristics.

More recently, U.S. Patent No. 5,018,060, issued to Gelb et al., teaches a technique whereby deta storage space may be allocated within peripheral data storage devices utilizing implied allocation besad

upon user specified parameters. A plurality of data classes, storage classes and management classes are specified which each define predetermined characteristics of diverse units of data, predetermined sets of storage performance and availability requirements and life cycle attributes for units of data. A plurality of storage groups which each define diverse predetermined performance device and management characteristics within the data storage subsystem are also defined. Each received space allocation request is then matched utilizing these parameters with the data, storage, and management classes for assignment to one of each of those classes to the unit of data related to the allocation request.

While this system represents a substantial advance in the automation of data storage system space allocation, a storage device may be selected for utilization without regard to multiple parameters which may be associated with data classes unless each such parameter is satisfied. Failing to satisfy one or more parameters associated with the data will result in the assignment of that data to a device within a storage group merely based upon the availability of space within that device.

In view of the above, it should be apparent that a need exists for a method and system which removes the burden of data storage system selection from the application programmer and storage administrator and which results in improved efficiency and data management. It would also be desirable to increase data storage system utilization by providing a system which permits all data storage systems to be candidates for space allocation for each new data set by adding a completely logical control wherein the best currently available data storage system may be selected based upon an associated set of data set preferences and/or requirements.

Disclosure of the Invention

A method and system are disclosed for automatically allocating space within a data storage system for multiple data sets which may include units of data, databases, files or objects. Each data set preferably includes a group of associated preference/requirement parameters which are arranged in a hierarchical order and then compared to corresponding data storage system characteristics for available devices. The data set preference/requirement parameters may include performance, size, availability, location, portability, share status and other attributes which affect data storage system selection. Data storage systems may include solid-state memory, disk drives, tape drives, and other peripheral storage systems. Data storage system characteristics may thus represent available space, cache, performance, portability, volatility, location, cost, fragmentation, and other characteristics which address user needs. The data set preference/requirement parameter hierarchy is established for each data set, listing each parameter from a "most important" parameter to a "least important" parameter. Each attempted storage of a data set will result in an analysis of all available data storage systems and the creation of a linked chain of available data storage systems representing an ordered sequence of preferred data storage systems. Data storage system selection is then performed utilizing this preference chain, which includes all candidate storage systems.

Brief Description of the Drawings

The invention will now be described, with reference to the accompanying drawings, in which:

Figure 1 is a pictorial representation of a distributed data processing system which may be utilized to implement the method and system of the present invention;

Figure 2 is a simplified block diagram illustrating the relationships of application programs to peripheral data storage systems in accordance with the method and system of the present invention;

Figure 3 is a simplified block diagram of a peripheral data storage system which may be utilized in accordance with the method and system of the present invention;

Figure 4A-4B is a pictorial representation of a hierarchical set of data set parameters which may be utilized in accordance with the method and system of the present invention;

Figures 5A-C illustrate multiple linked preference chains of data storage devices which have been created in accordance with the method and system of the present invention;

Figures 6A-C depict a high level logic flowchart which illustrates a method for implementing the present invention.

Detailed Description of the Invention

With reference now to the figures and in particular with reference to **Figure 1**, there is depicted a pictorial representation of a distributed data processing system **8** which may be utilized to implement the method and system of the present invention. As may be seen, distributed data processing system **8** may include a plurality of networks, such as Local Area Networks (LAN) **10** and **32**, each of which preferably includes a plurality of individual computers **12** and **30**, respectively. of course, those skilled in the art will appreciate that a plurality of Intelligent Work Stations (IWS) coupled to a host processor may be utilized for each such network.

As is common in such data processing systems, each individual computer may be coupled to a storage device **14** and/or a printer/output device **16**. One or

more such storage devices **14** mey be utilized, in accordance with the method of the present invention, to store the various data objects or documents which may be periodically accessed and processed by e user within distributed dete processing system **8**, in accordance with the method and system of the present invention. In a manner well known in the prior art, each such data processing procedure or document may be stored within e storage device **14** which is associated with a Resource Manager or Library Service, which is responsible for maintaining and updating all resource objects associated therewith.

Still referring to **Figure 1**, it may be seen that distributed data processing system **8** mey also include multiple mainframe computers, such as mainframe computer **18**, which may be preferably coupled to Local Area Network (LAN) **10** by means of communications link **22**. Mainframe computer **18** may also be coupled to e peripheral data storage system **20** which may serve es remote storage for Local Area Network (LAN) **10**. A second Local Area Network (LAN) **32** may be coupled to Local Aree Network (LAN) **10** vie communications controller **26** and communications link **34** to e getewey server **28**. Geteway server **28** is preferably en individual computer or Intelligent Work Station (IWS) which serves to link Locel Aree Network (LAN) **32** to Local Aree Network (LAN) **10**.

As discussed above with respect to Local Aree Network (LAN) **32** and Local Area Network (LAN) **10**, e plurelity of deta processing procedures or documents mey be stored within peripherel deta storege system **20** end controlled by meinframe computer **18**, es Resource Menager or Library Service for the deta processing procedures and documents thus stored.

Of course, those skilled in the art will eppreciate that meinfreme computer **18** mey be located e greet geographical distance from Locel Aree Network (LAN) **10** and similarly Local Area Network (LAN) **10** mey be located e substentiel distence from Local Area Network (LAN) **32**. That is, Local Area Network (LAN) **32** mey be located in California while Local Area Network (LAN) **10** mey be located within Texas and mainframe computer **18** mey be located in New York.

As will be appreciated upon reference to the foregoing, it is often desirable for users within one portion of distributed data processing network **8** to store or access a data object or document in another portion of data processing network **8**. In view of the wide variety of such storege devices which may be available within distributed data processing system **8**, end the diverse characteristics of those devices it should be apparent that a need exists for a method and system which allocates space within those storage devices in a manner which most closely matches the user's desires.

Referring now to **Figure 2**, there is depicted a simplified block diagram illustrating the relationships of epplication programs to peripheral deta storage systems in accordance with the method and system of the present invention. All objects depicted within **Figure 2**, with the exception of peripheral data storage system **20**, which is intended to include an entire storage subsystem, are contained within mainframe computer **18**, as an example. A large plurality of epplication programs **40** execute within mainframe computer **18**. Software connections to peripheral control programs **42** are provided in a manner well known to those having ordinary skill in the art. Data Facility Product (DFP) **44** includes programming which implements the present invention. A portion of DFP **44** includes ISMF **46**, a terminal support program known to those having ordinary skill in the ert which may be utilized for permitting mainframe computer **18** to operate with one or more terminals. Double-headed arrow **48** represents the connection to one or more terminals.

Data mover progrem **50** actually causes deta movement between main memory (not shown) of meinframe computer **18** and peripheral deta storege **20**. Data mover **50** operates with IOS Input Output System **56**, e pert of the operating system of mainfreme computer **18** to effect trensfer of deta between the mein memory (not shown) of meinfreme computer **18** end peripheral date storege **20** vie input output channels **58**. Coordinetion of such peripheral operetions is eccomplished via control date sets (CDS) **52**; most of which ere known in the prior ert; however, the new data structures utilizes for eutometically elocating data system storage spece in eccordance with the present invention ere illustreted within the flowchart formed by **Figures 6A-6C**. Operating in conjunction with DFP **44** is DFHSM **54**, e hierarchical storege manager. DFHSM **54** provides for migration, recall, beck up, eto. of dete volumes.

With reference now to **Figure 3**, there is depicted e simplified block diegram of a peripheral dete storage system which may be utilized in eccordance with the method and system of the present invention. As illustrated within **Figure 2** above, peripheral data storage system 20 is attached to channels **58**. A primary or level 0 number of hierarchical data storage includes cached DASD sub-system(s) **60** while level 1 of the hierarchy enclosed medium-performance DASD **62**. High performance DASD may be a part of the primary level. Level 2 of the hierarchy may include directly connected tape subsystem(s) **66** or buffered tape subsystem(s) **68**. A level 3 of the hierarchy includes shelf storage unit(s) **70**. As is well known in the art, operators mey hand carry tape reels, volumes, between storage unit(s) **70** and tape drives of tape subsystem(s) **66** and **68**. An automatic deta media library (tape or disk) **72** may also be included in peripherel deta storage **20**. Library **72** typicelly includes a medle handling library portion and a plurality of recorders/readers (tape or disk) DEV **74** and a library con-

trol CONTR 76. Shelf storage unit(s) 70 are operatively associated with library 72. A storage console 80 is the terminal which is utilized to communicate with mainframe computer 18 for manual aspects of the peripheral data storage 20 and may be used as the terminal for ISMF 46. Library 72 may be a lower (higher numberad) level of the data storage hierarchy, the level being a matter of design choice.

Rafarring now to **Figuras 4A-4B**, thare is depicted a pictorial representation of a hierarchical set of data sat paramatars which may be utilizad in accordance with the mathod and system of the present invention. As illustrated, tha usar or tha system may seiect a plurality of data sat parametars which, as descriibad abova, may include parformance, size, availabiiity, iocation, portability, share status and other attributes which affect data storage systam selection. The exampla illustrated within **Figuras 4A and 4B** include five data set parameters listed within columns **90, 92, 94, 96,** and **98**. Thus, in the ordered list of data set parametars illustrated within **Figures 4A** and **4B**, the user or systam has seiected a iocation within column **90** as tha highest priority parameter for data storage system space aiiocation for this particular data sat. Next in importance is tha ability of the data storage device to perform a "concurrent" copy, that is a spacific type of backup copy capability. Thereaftar, performance or speed of access, cache capabiiity and finally tha amount of free space within a particular storaga device are iisted as parameters to be considered in aiiocating space within a data storage system for this particular data set. Of course, those skiiad in the art will appraciate that one or more of these paramatars may raprasent raquirements while tha remaining parameters may reprasant prefarences. Thus, the failure of a storage device to meat a required data set parameter will be causa for that data storage device to be rejected as a possibie location for storage of this data sat.

Still referring to **Figures 4A** and **4B**, it may be saan that for this particular data sat, the prefarred aiiocation of space within a storage device will comprise a local storaga davica which is concurrent copy enabled, closa to the required performanca, having an active cache and the largest amount of free space. In the event a concurrent copy enabied storage device is not available locally, a device which is not concurrant copy anabiad will be salactad prior to selection of a remote storaga device, upon a review of the hiararchical data sat parameter listing contained within **Figuras 4A** and **4B**. Upon raference to these figures, thosa skilled in tha art will appraciata that by generating a hierarchical list of data set parameters in the manner sat forth within thasa figuras, a user may spacify multiple required or preferred charactaristics for a data storaga davice which will be automatically considered prior to allocating space within the data storage subsystem for storage of this data set. Further, by specifying certain parameters as "optional" or as "prefarances," tha system may salactively allocata space within a storage device which meets an optimal subsat of tha data set parametars which have been considered in a hiararchical order specified by tha user or the system.

With **rafarance** now to **Figuras 5A-5C**, thara are illustrated multiple linkad preferenca chains of data storaga devicas which hava baan created in accordance with the method and system of the present invention. As illustrated within **Figure 5A**, four saparata storaga devices are present within one or mora data storage subsystams. Storaga devicas A, B, C, and D. As illustrated, storage devices A and C are cacha enablad, whila storaga davicas B and D are non-cache enabled. Thus, as illustrated within **Figure 5B**, if the data set parameter associated with a particular data set indicates a preference for cache enabled storage, these four storage davices will ba linked together in a prafarance chain in tha manner dapicted within **Figure 5B**. That is, storage device A and storaga devica C are preferred over storage devices B and D. However, in the avent the data set parameters associated with a particular data set specify a non-cache enabled requirament, the preferance chain of data storage devices will be created in the manner set forth within **Figure 5C**. That is, storage davice B and D sense the non-cache enabled status is a requirement for this particular data set.

While the preference chains illustrated within **Figures 5B** and **5C** rapresent the consideration of a singie parameter (cache) those skilied in the art will appreciate that a preference chain may be craatad by analyzing tha hierarchical data set parametar listing associated with each data set. Thus, the hierarchical data sat parameter listing set forth within **Figures 4A** and **4B** will result in a linkad preference chain of data storaga devicas which meet all or soma of the data set parameters from a most dasirable data storage device to a least desired data storage device.

Referring now to **Figures 6A-6C**, when joined in tha manner indicated, there is depicted a high level logic flowchart which illustratas a procass for implementing the present invantion within Data Facility Product (DFP) **44** (see **Figure 2**). As illustrated, the process begins at block **110** and thereaftar passes to block **112**. Block **112** illustrates a determination of whathar or not a data sat is to ba storad. If not, tha process merely iterates until such tima as a data set is ready to ba stored.

Still referring to block **112**, once a data set has baen identified as a candidata for storage, block **114** illustrates tha retrieval of the associata preference/requirement paramatars which ara associatad with that data set. Next, tha process passes to block **116** to datarmine which storaga device charactaristics naad to be evaluatad for storage of this data set. As dascribed above, each group of associated preferanca/require-

ment parameters which are associated with a date set mey include performence, size, evellebility, location, portebility, share stetus or other attributes which may effect deta storege system selection. Dete storage systems include various characteristics which reflect evailable space, cache, performence, portability, volatility, location, cost, fregmentation, end other cheracteristics. Thus, those skilled in the ert will eppreciete thet those characteristics which identify e particular deta storage device may comprise a more extensive list then mey be specified for e particuler deta set. Thus, block **116** illustrates e determinetion of which storege device chereteristics must be evaluated in order to determine whether or not those cheracteristics satisfy the limited set of essocieted preference/requirement parameters associated with e particular data set.

Next, referring to block **118**, the process illustrates e determination of which data set parameters within the associated preference/requirement peremeters for a particular deta set ere required characteristics. Thet is, characteristics which the candidete storage device must include in order to be e candidete for allocation of space for this data set. Thereafter, the process passes to block **120**. Block **120** illustrates a determination of the hierarchical order for characteristic evaluation. Referring to **Figures 4A** and **4B**, it may be seen that the method and system of the present invention utilizes en associated set of preference/requirement perameters for each data set which are erranged in a hierarchical order as selected by a user or the system. Thus, certain parameters are thought to be of greater importance than other parameters and the characteristics for each storege device must be evaluated in consideration of this hierarchical order.

Next, referring to block **122**, the process of creating a preference chain of candidate storege devices is initiated. The first or next storage device to be inserted into the preference chain is identified. Thereafter, the process passes to block **124**. Block **124** illustrates a determination of whether or not a storage device exists to be inserted into the preference chain and if so, the process passes to block **126**. Block **126** illustrates e determination of whether or not thet perticuler storage device lacks e required characteristic and if so, the process returns in an iteretive fashion to block **122** to identify the next storege device to be considered for insertion into the preference chein.

Referring egein to block **126**, in the event the candidate storage device does not lack a required characteristic, the process passes to block **128**. Block **128** illustrates the selection of the first or next hierarchical chereteristic to evaluete. Thereefter, the process passes to block **130**. Block **130** illustrates a determination of whether or not e hierarchical characteristic exists to be evaluated end if so, the process passes to block **132**. Block **132** illustretes the retrieval of the storage device chereteristic which corresponds to the current hierarchicel position. Thereefter, the process passes to block **134**.

Block **134** illustrates the pointing to the first or next storage device which is elreedy present within the preference chein. Next, the process passes to block **136**. Block **136** illustretes e determination of whether or not a storage device elready exists within the preference chein and if so, the process passes to block **138**. Block **138** illustrates the checking of ell previously evelueted hierarchical cheracteristics and the process then passes to block **140**.

Block **140** illustretes a determination of whether or not the currently evelueted cheracteristic is not equal to that characteristic within the preference chain (i.e., one is "Local" end one is "Remote"). If not, or, referring to blocks **130** and block **136**, if e candidate storege device does not exist, the process passes to block **142**. Block **142** illustrates the insertion of that storege device into the preference chain utilizing the preference chain pointer and the process then returns to block **122**, in an iterative fashion, to identify the next storage device to be inserted into the preference chain.

Referring now to **Figure 6B**, in the event the currently evaluated characteristic is equal to the characteristic in the previously processed device, the process passes, via connector **150**, to block **152**. Block **152** illustrates a determination of whether or not the characteristic under evaluation is an "ON/OFF" type characteristic. That is, a characteristic having two states. If so, the process passes to block **154**. Block **154** illustrates a determination of whether or not the preference chein pointer is at the top hierarchical characteristic state for this particular characteristic. If so, the process returns, via connector **146** to block **128**, in an iterative feshion, to select the next hierarchical characteristic to evaluate. In this manner, if the higher hierarchical characteristic state is the current state, differentiation between two storage devices must occur based upon an evaluation of the next hierarchical characteristic which corresponds to a parameter for that particular deta set.

Still referring to block **154**, in the event the preference chein pointer is not et the top hierarchical characteristic state, the process passes to block **156**. Block **156** illustrates a determination of whether or not the chained storage device at the current point within the preference chain is the same characteristic state es the device under consideration. If so, the process again returns, via connector **146** to block **128** in an iterative feshion es described ebove. Alternetely, if this condition is not true, the process passes vie connector **148** to block **134**, in en iterative fashion, to point to the next storage device within the preference chein.

Referring egein to block **152**, in the event the cheracteristic under consideretion is not en

"ON/OFF" type characteristic, the process passes to block **158**. Block **158** illustrates a determination of whether or not the characteristic involves a range of numbers. For example, a data set may have specified as a preference for storage devices a speed of access. In such a circumstance, the process will pass from block **158** to block **160**. Block **160** illustratas a determination of whether or not the preference chain includes thase numbers in an ascanding or descending format. If these numbers are listed within the preference chain in an ascending format, the process then passes to block **162** which illustrates a determination of whether or not the number for the currently chained device is less than or equal to the number for tha inserting device. If so, the process returns to block **128** in an iterative fashion via connector **146**. Alternately, in the event the number for the chained device is not lass than or equal to the number for the inserting device, the process passes in an iterative fashion to block **134**, via connector **148**.

Referring again to block **160**, in the event the range of numbers characteristic is listed within the preferenca chain in a descending manner, the process passes from block **160** to block **164**. Block **164** illustrates a determination of whether or not the number for the inserting device is less than or equal to the number for the device already present within the preference chain. If so, the process returns to block **128** in an iterative fashion, via connector **146**. Alternately, in the event the number for the inserting device is not less than or equal to the number for the device present within the preference chain, tha process returns, in an iterative fashion, to block **134** via connector **148**.

Referring again to block **158**, in the event the characteristic under consideration is neither a "ON/OFF" type characteristic nor a range of numbers characteristic, the process passes to block **166**. Block **166**. Block **166** illustrates the concept that different types of characteristics may be associated with a data sat. Block **166** is intended to illustrate the ability of the method and system of the present invention to accommodate the processing of as yet undetermined types of characteristics which may be associated with a data sat and utilized to automate the allocation of space within a data storage system.

Referring to now to block **124** of **Figure 6A**, in the event no more candidate devices exist to be inserted into the preference chain, the process passes from block **124** to block **168** within **Figure 6C** via connector **146**. Block **168** illustrates the pointing to the first or next storage device within the preference chain. Thereafter, tha process passes to block **170**. Block **170** illustrates a determination of whether or not a storage device exists within the preference chain which satisfias all, or an optimal subset of the hierarchical characteristics which correspond to the parameters associated with a particular data set. If so, the process passes to block **172**. Block **172** illustrates the allocation of storage space on that device for the data set associated with those paramatars and the process then passes to block **174**. Block **174** illustrates a determination of whather or not the allocation of storage space on that devica was successful and if not, the process returns, in an iterative fashion, to block **168** to salact the next storage device within the prafarence chain. Howevar, in tha event the allocation of storage space was successful, the process passas to block **178** and returns.

Referring again to block **170**, in the event no device exists within the preferenca chain which has been created by an evaluation of the data sat parameters associated with a particular data set, the process passes to block **176**. Block **176** illustratas the failing of the storage request and the process then passes to block **178** and returns.

Upon referance to the foregoing those skilled in the art will appreciate that the Applicant in the present application has creatad a mathod and system whereby a listing of requirement/preference parametars may be associated with each data set within the system and evaluatad in a hierarchical manner in order to optimize the automated allocation of storage space within a data storaga system in a data processing system. By hierarchically ordering the parameters associated with each data sat and spacifying thosa parameters as either "requirements" or "preferences," an optimal data storaga device may be salected for storage of a data set which satisfias each of those characteristics, or, alternativaly, satisfies an optimal number of those characteristics in the stated hierarchical order. In this manner, the allocation of storage space within a data storage system may be made mora efficient by automating the process such that all storage devices within the system may ba considered as candidatas for each data set to be stored therain.

Claims

1. A method for use in a data storage system for automated data storage system spaca allocation, the system having a plurality of data storage davices, said method comprising tha steps of:

   associating a listing of charactaristics representing data storage devica performance and availability parameters with aach of said plurality of data storage devicas;

   associating a listing of data sat parameters representing salactabla data storaga system characteristics with aach of a plurality of data sets within said data processing systam;

   comparing a list of data set parametars associated with a particular data set with said listing of characteristics associated with each data storage device in a spacified hierarchical order in response to an attempted storaga of said particular

data set;

automatically storing said particular data set within a first selected one of said plurality of data storage devices in response to a determination that said first selected one of said plurality of data storage devices satisfies said entire list of data set parameters; and

automatically storing said particular data set within a second selected one of said plurality of data storage devices in response to a determination that no data storage device satisfies said entire list of data set parameters and a determination that said second selected one of said plurality of data storage devices satisfies an optimal subset of said list of data set parameters within said specified hierarchical order.

2. A method as claimed in Claim 1, wherein said step of comparing further comprises the step of creating a linked chain of available storage devices representing an ordered sequence of preferred data storage devices.

3. A method as claimed in Claim 1, wherein said step of associating a listing of data set parameters comprises the step of associating a listing of data set parameters representing both required and preferred selectable data storage system characteristics with each of a plurality of data sets within said data processing system.

4. A method as claimed in Claim 1, wherein said step of associating a listing of data set parameters includes the step of associating a parameter specifying a preferred data storage system performance characteristic with each of said plurality of data sets.

5. A method as claimed in Claim 1, wherein said step of associating a listing of data set parameters includes the step of associating a parameter specifying a preferred data storage system size characteristic with each of said plurality of data sets.

6. Amethod as claimed in Claim 1, wherein said step of associating a listing of data set parameters includes the step of associating a parameter specifying a preferred data storage system location characteristic each of said plurality of data sets.

7. A data processing system for enabling automated data storage system space allocation among a plurality of data storage devices within said data processing system, said data processing system comprising:

means for associating a listing of characteristics representing data storage device performance and availability parameters with each of said plurality of data storage devices;

means for associating a listing of data set parameters representing selectable data storage system characteristics with each of a plurality of data sets within said data processing system;

means for comparing a list of data set parameters associated with a particular data set with said listing of characteristics associated with each data storage device in a specified hierarchical order in response to an attempted storage of said particular data set;

means for automatically storing said particular data set within a first selected one of said plurality of data storage devices in response to a determination that said first selected one of said plurality of data storage devices satisfied said entire list of data set parameters; and

means for automatically storing said particular data set within a second selected one of said plurality of data storage devices in response to a determination that no data storage device satisfies said entire list of data set parameters and a determination that said second selected one of said plurality of data storage devices satisfies an optimal subset of said list of data set parameters within said specified hierarchial order.

8. A system as claimed in Claim 7, wherein said means for comparing a list of data set parameters further comprises the step of creating a linked chain of available storage devices representing an ordered sequence of preferred data storage devices.

9. A system as claimed in Claim 7, wherein said means for associating a listing of data set parameters comprises means for associating a listing of data set parameters representing both required and preferred selectable data storage system characteristics with each of a plurality of data sets within said data processing system.

10. A system as claimed in Claim 7, wherein said means for associating a listing of data set parameters includes means for associating a parameter specifying a preferred data storage system performance characteristic with each of said plurality of data sets.

11. A system as claimed in Claim 7, wherein said means for associating a listing of data set parameters includes means for associating a parameter specifying a preferred data storage system size characteristic with each of said plurality of data sets.

12. A system as claimed in Claim 7, wherein said means for associating a listing of data set parameters includes means for associating a parameter specifying a preferred data storage system location characteristic each of said plurality of data sets.

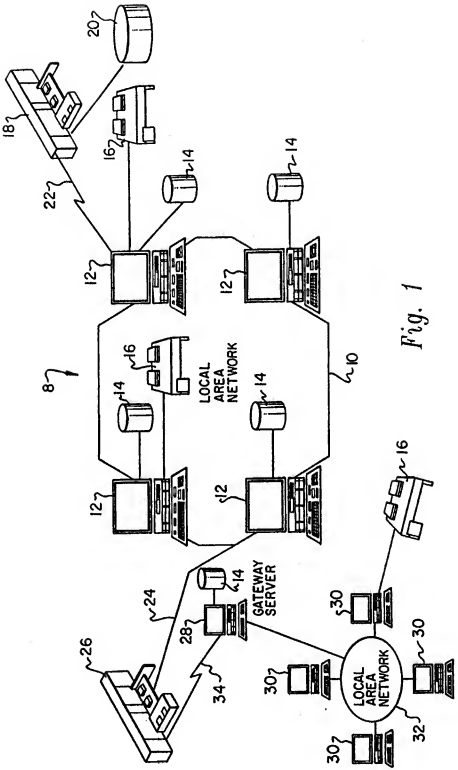

20
18
16
22
14
14
12
12
8
16
LOCAL AREA NETWORK
14
10
12
16
24
14
GATEWAY SERVER
28
30
26
34
30
LOCAL AREA NETWORK
30
30
32

Fig. 1

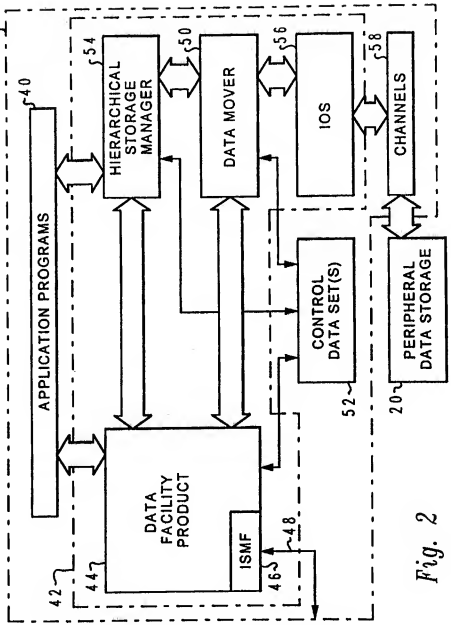

18
40
APPLICATION PROGRAMS
54
HIERARCHICAL STORAGE MANAGER
50
DATA MOVER
56
IOS
58
CHANNELS
DATA FACILITY PRODUCT
ISMF
48
46
44
42
CONTROL DATA SET(S)
52
PERIPHERAL DATA STORAGE
20

Fig. 2

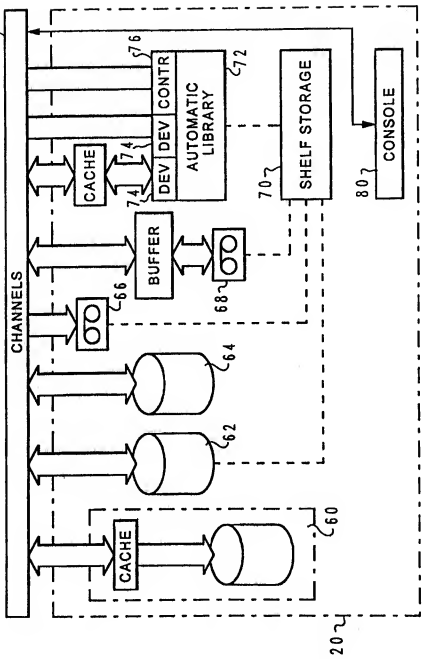

58
CHANNELS
CACHE
60
62
64
66
BUFFER
68
CACHE
74
74
76
DEV
DEV
CONTR
AUTOMATIC LIBRARY
72
70
SHELF STORAGE
80
CONSOLE
20

Fig. 3

LOCATION	CONCURRENT COPY	PERFORMANCE	CACHE	FREE SPACE
LOCAL	ENABLED	CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		NEXT CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		ETC	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
	NOT ENABLED	CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		NEXT CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		ETC	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST

TO FIGURE 4B

Fig. 4A

FROM FIGURE 4A

LOCATION (90)	CONCURRENT COPY (92)	PERFORMANCE (94)	CACHE (96)	FREE SPACE (98)
REMOTE	ENABLED	CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		NEXT CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		ETC	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
	NOT ENABLED	CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		NEXT CLOSEST	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST
		ETC	ACTIVE	LARGEST
				MEDIUM
				SMALLEST
			NOT ACTIVE	LARGEST
				MEDIUM
				SMALLEST

Fig. 4B

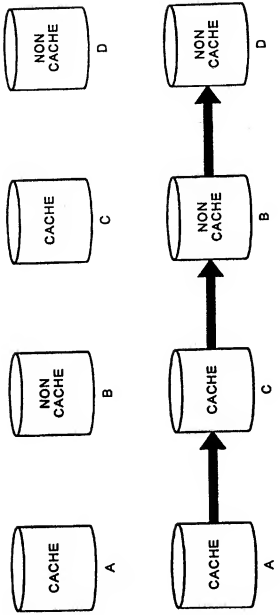


Fig. 5A

Fig. 5B

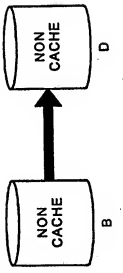
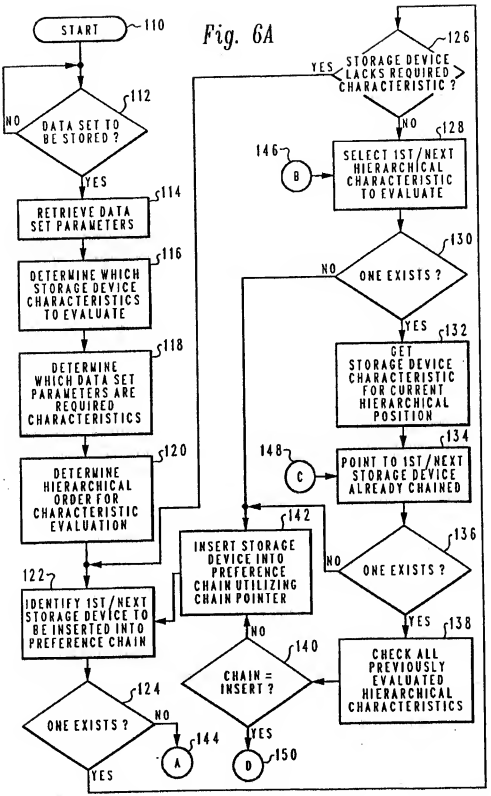


Fig. 5C


START
110
Fig. 6A
112
DATA SET TO BE STORED ?
NO
YES
114
RETRIEVE DATA SET PARAMETERS
116
DETERMINE WHICH STORAGE DEVICE CHARACTERISTICS TO EVALUATE
118
DETERMINE WHICH DATA SET PARAMETERS ARE REQUIRED CHARACTERISTICS
120
DETERMINE HIERARCHICAL ORDER FOR CHARACTERISTIC EVALUATION
122
IDENTIFY 1ST/NEXT STORAGE DEVICE TO BE INSERTED INTO PREFERENCE CHAIN
124
ONE EXISTS ?
NO
YES
144
A
126
STORAGE DEVICE LACKS REQUIRED CHARACTERISTIC ?
YES
NO
146
B
128
SELECT 1ST/NEXT HIERARCHICAL CHARACTERISTIC TO EVALUATE
130
ONE EXISTS ?
NO
YES
132
GET STORAGE DEVICE CHARACTERISTIC FOR CURRENT HIERARCHICAL POSITION
148
C
134
POINT TO 1ST/NEXT STORAGE DEVICE ALREADY CHAINED
136
ONE EXISTS ?
NO
YES
138
CHECK ALL PREVIOUSLY EVALUATED HIERARCHICAL CHARACTERISTICS
140
CHAIN = INSERT ?
NO
YES
142
INSERT STORAGE DEVICE INTO PREFERENCE CHAIN UTILIZING CHAIN POINTER
150
D

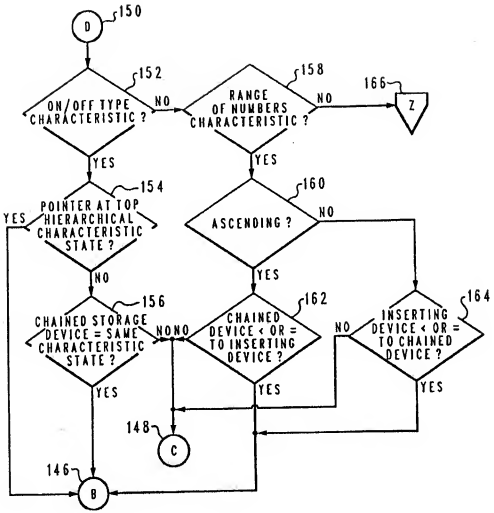

D
150
ON/OFF TYPE CHARACTERISTIC ?
152
NO
YES
RANGE OF NUMBERS CHARACTERISTIC ?
158
NO
166
Z
YES
POINTER AT TOP HIERARCHICAL CHARACTERISTIC STATE ?
154
YES
NO
ASCENDING ?
160
NO
YES
CHAINED STORAGE DEVICE = SAME CHARACTERISTIC STATE ?
156
NO
NO
YES
CHAINED DEVICE < OR = TO INSERTING DEVICE ?
162
YES
INSERTING DEVICE < OR = TO CHAINED DEVICE ?
164
NO
YES
148
C
146
B

Fig. 6B

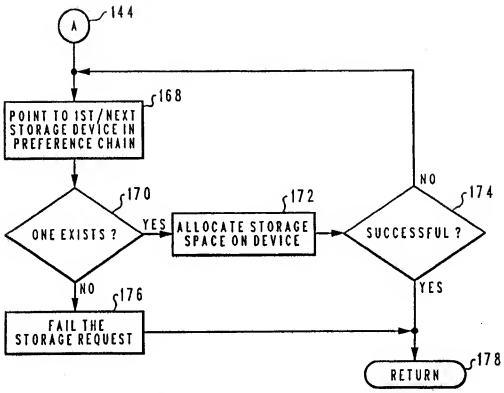

A
144
POINT TO 1ST/NEXT STORAGE DEVICE IN PREFERENCE CHAIN
168
ONE EXISTS ?
170
YES
ALLOCATE STORAGE SPACE ON DEVICE
172
SUCCESSFUL ?
174
NO
YES
NO
FAIL THE STORAGE REQUEST
176
RETURN
178

Fig. 6C

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 1165

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR-A-2 677 146 (DIGITAL EQUIPMENT CORP) 4 December 1992 * the whole document *	1-12	G06F3/06
D,A	US-A-5 018 060 (GELB JACK P ET AL) 21 May 1991 * column 4, line 14 - column 5, line 11 *	1-12	
A	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 17, no. 5, October 1974 NEW YORK, US, pages 1472-1474, ANONYMOUS 'Cost Oriented Algorithm for Data Set Allocation in Storage Hierarchies Based on Fundamental Data Set Characteristics. October 1974.' * the whole document *	1,7	
A	WO-A-90 07746 (STORAGE TECHNOLOGY CORP) 12 July 1990 * page 4, line 1 - page 6, line 2 * * page 17, line 1 - page 20, line 25 *	1-12	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 June 1995	Nielsen, O

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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